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Cameron

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[54] **FIXED VOLUME PTC AIR HEATER WITH HEAT OUTPUT ADJUSTED BY A DAMPER CONTROLLING AIR FLOW OVER THE PTC ELEMENT**

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[51] **Int. Cl.^{5}** **H05B 3/14;** F24H 3/04; F28F 27/02; H01C 7/02

[52] **U.S. Cl.** **392/360;** 165/103; 165/122; 219/505; 251/251; 251/253; 392/363; 392/368; 392/379; 392/383

[58] **Field of Search** 392/347-376, 392/379-385; 219/205, 505; 251/251, 253; 165/103, 121, 122

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Primary Examiner—Anthony Bartis
Attorney, Agent, or Firm—Lee, Mann, Smith, McWilliams, Sweeney & Ohlson

[57] **ABSTRACT**

An electric forced air heating device using PTC elements for heating and having a fixed volume of airflow established by a blower driven at a constant rate. A pair of parallel air paths are established in the device, with one air path having the PTC elements fixedly located therein. A laterally movable damper is used to control airflow through the two air paths, and is positioned proximate the PTC elements a fixed distance therefrom so that as the damper is shifted, airflow proportionally increases through one of the air paths and proportionally decreases through the other air path to control the heat output of the PTC elements. The energization of the PTC elements and blower is controlled by a switch activated by movement of the damper.

16 Claims, 3 Drawing Sheets

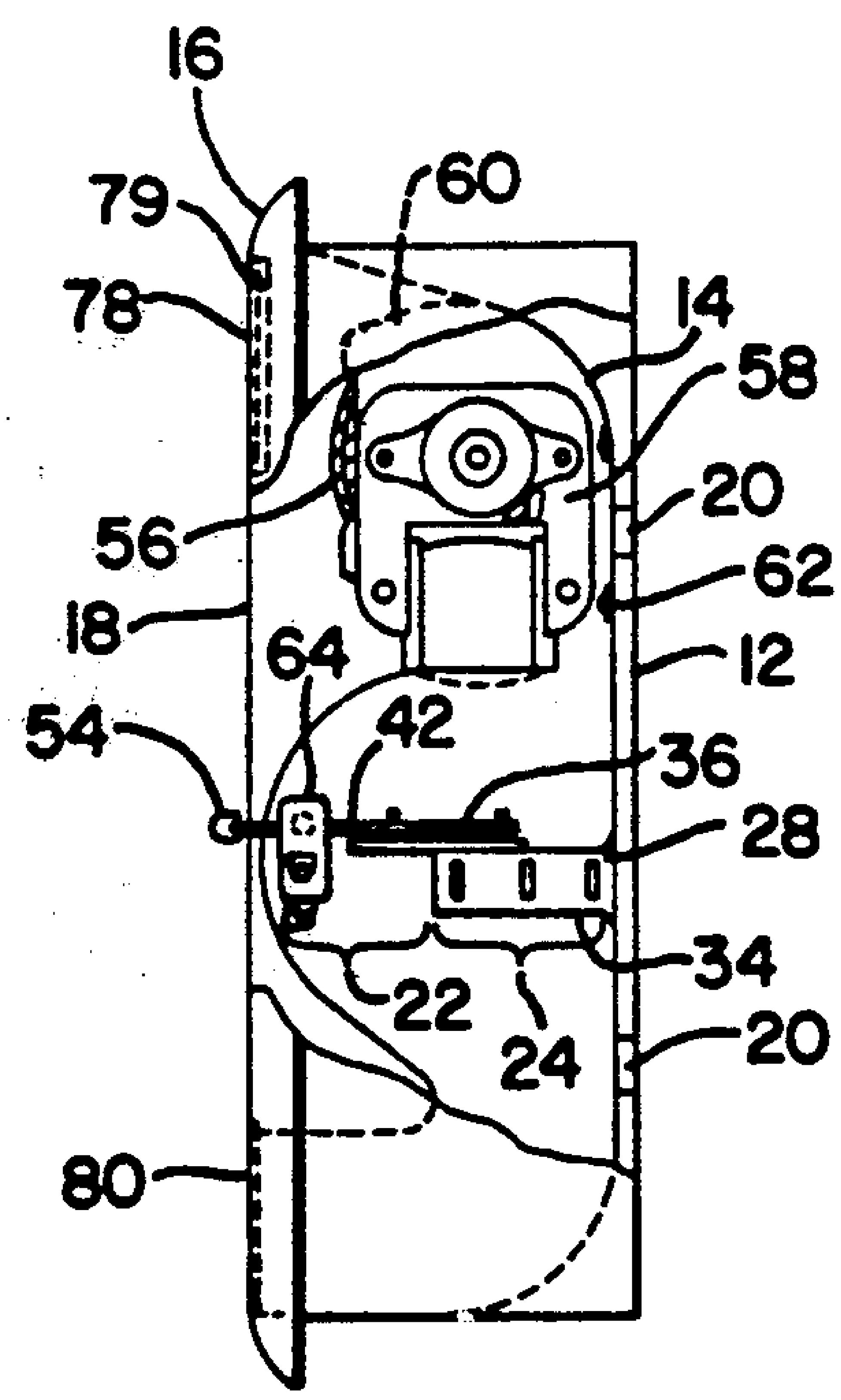

FIG. 1

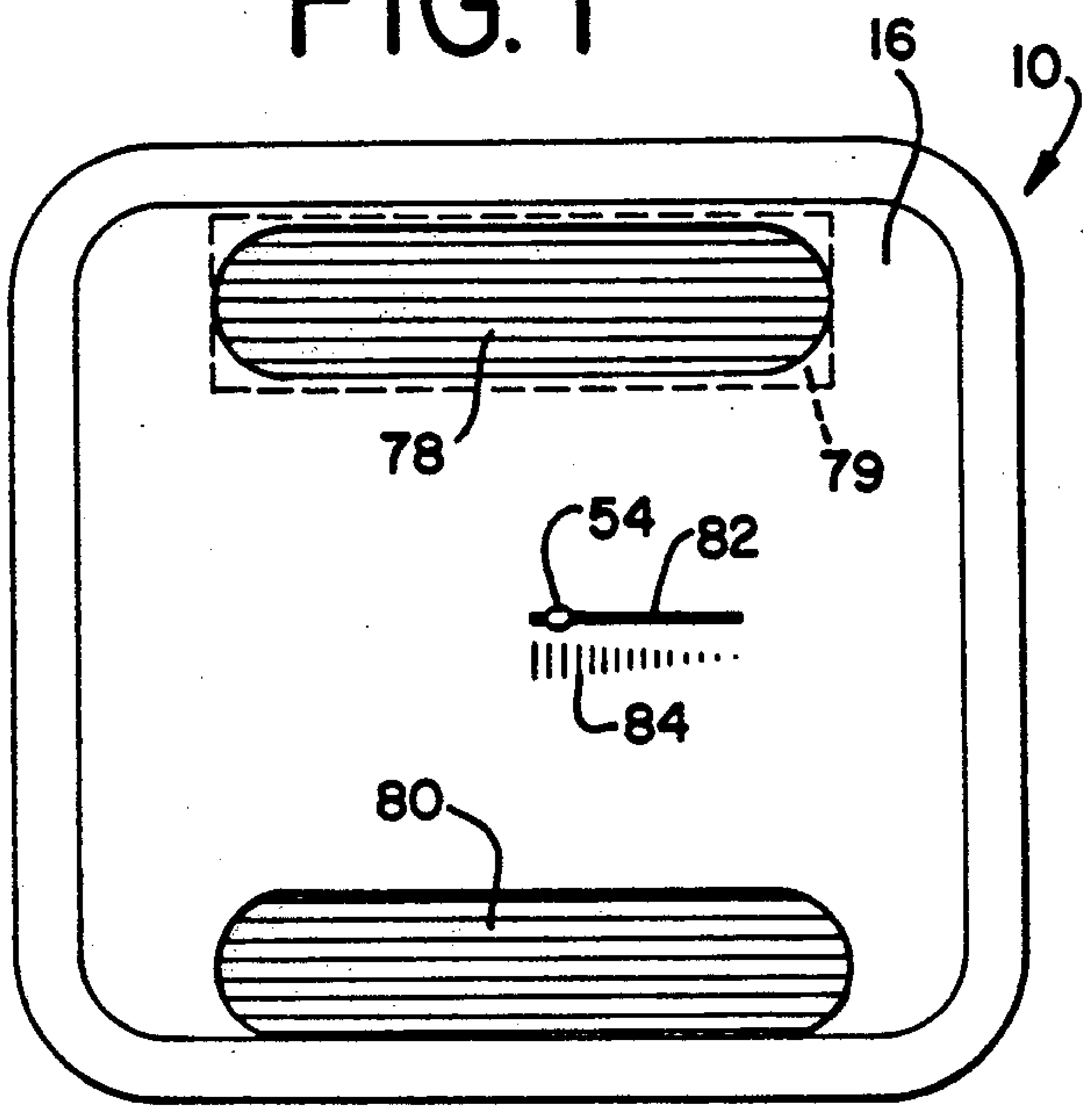

FIG. 2

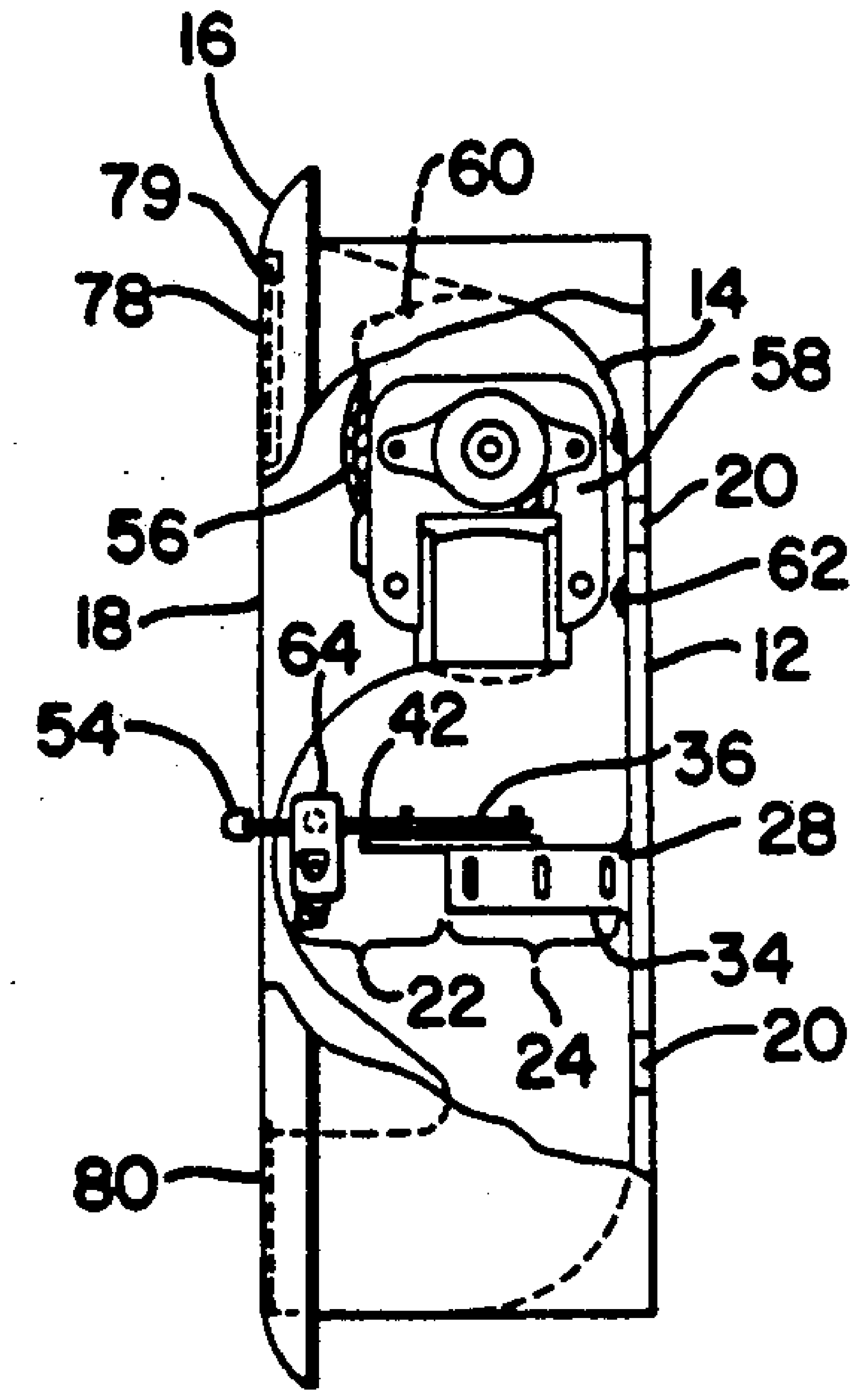

FIG. 3

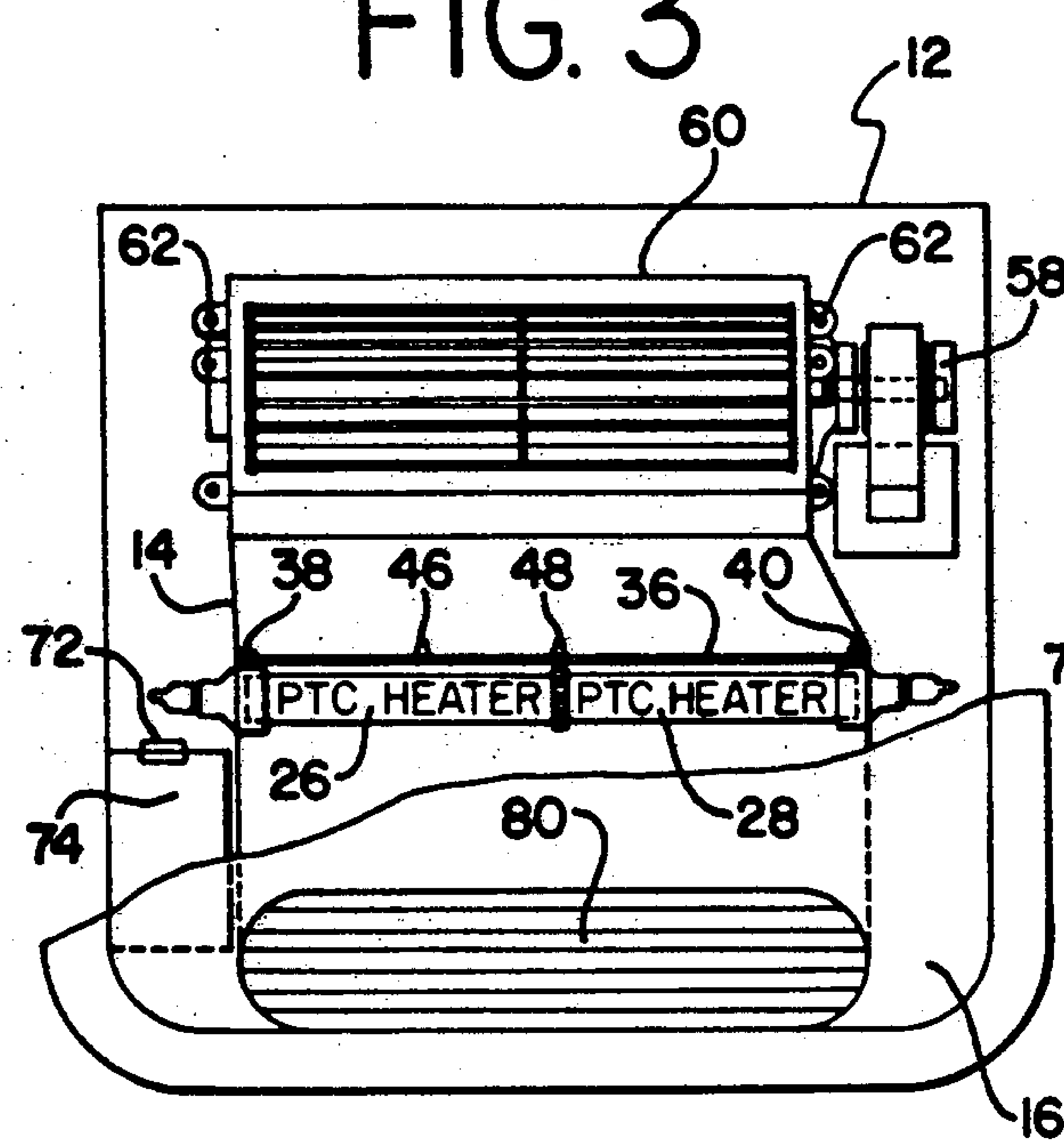

FIG. 4

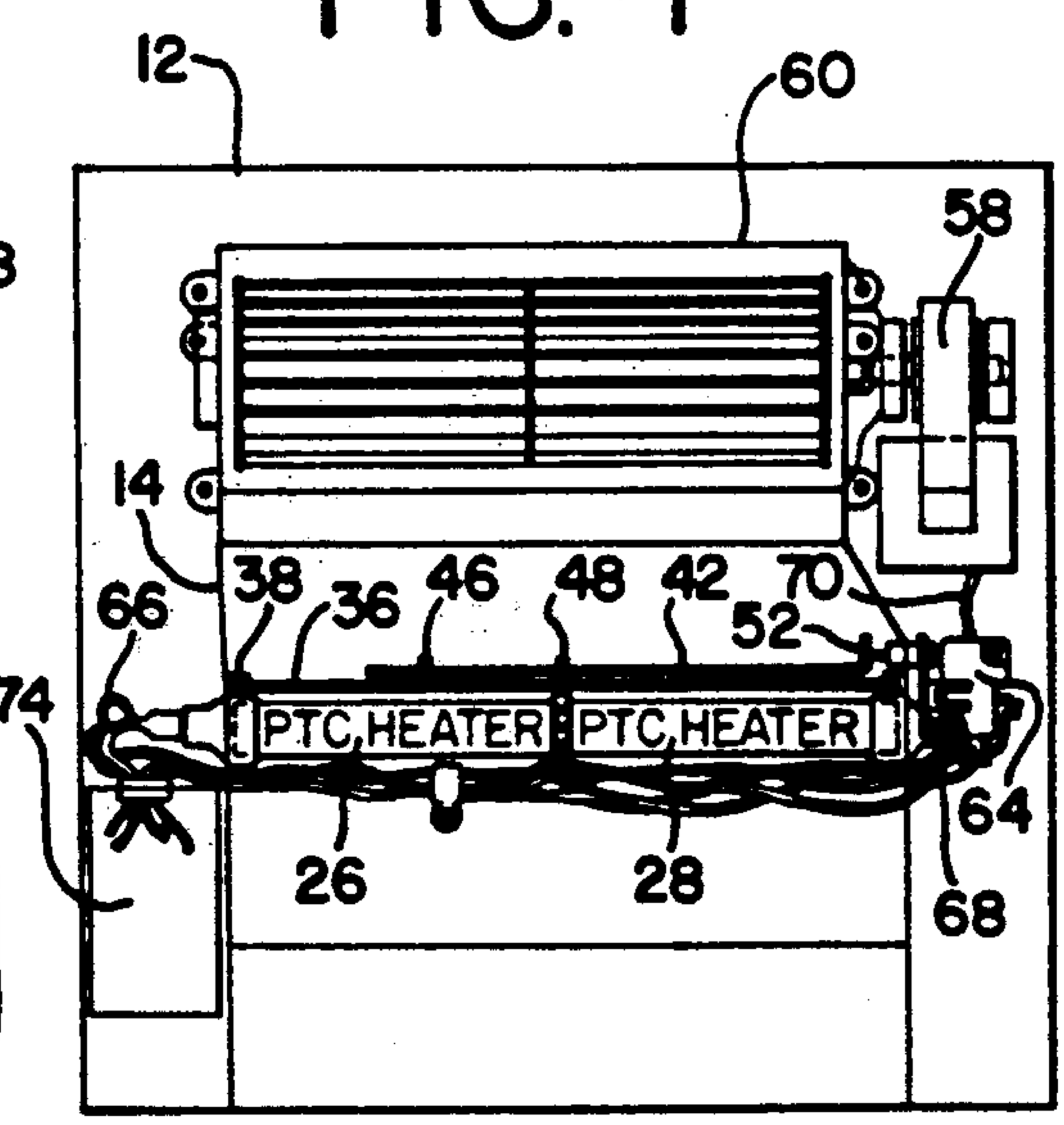

FIG. 5A

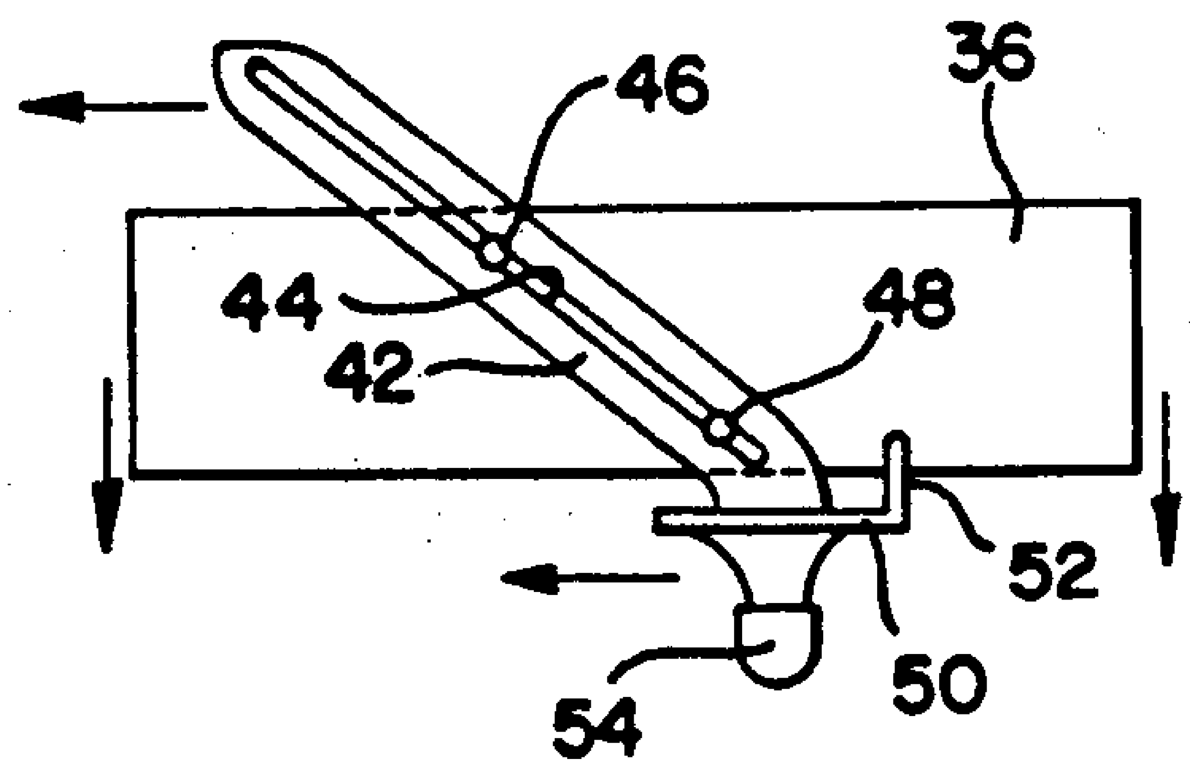

FIG. 5B

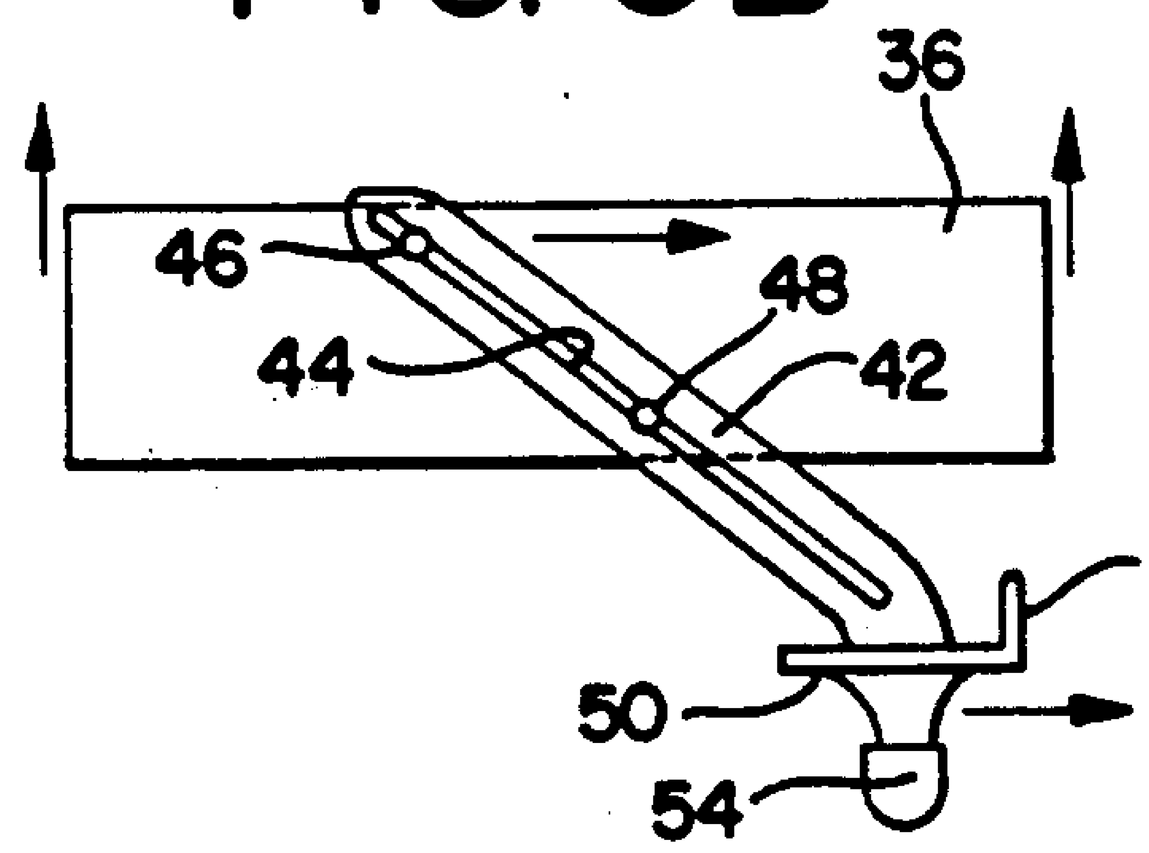

FIG. 6

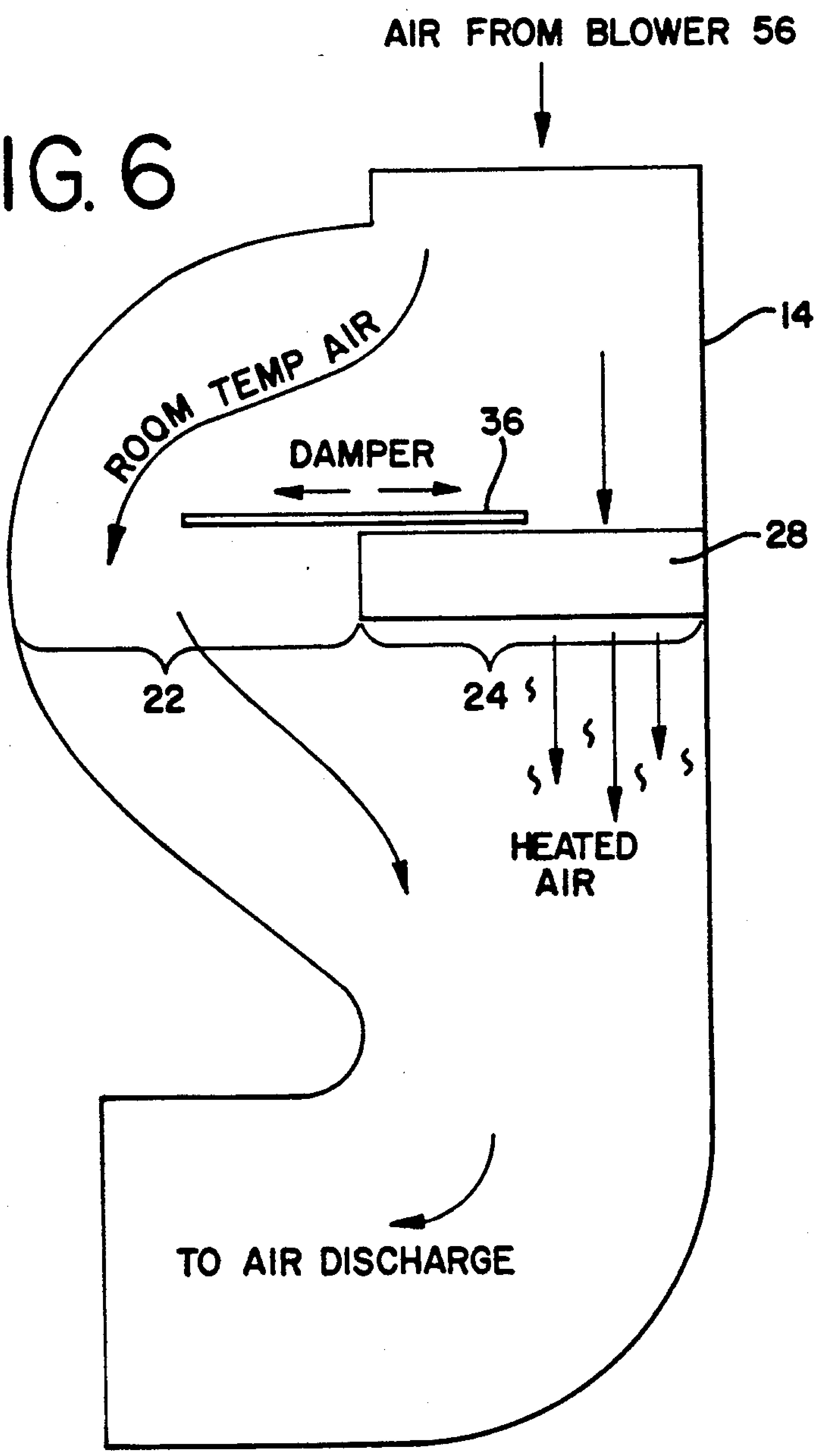

FIG. 7

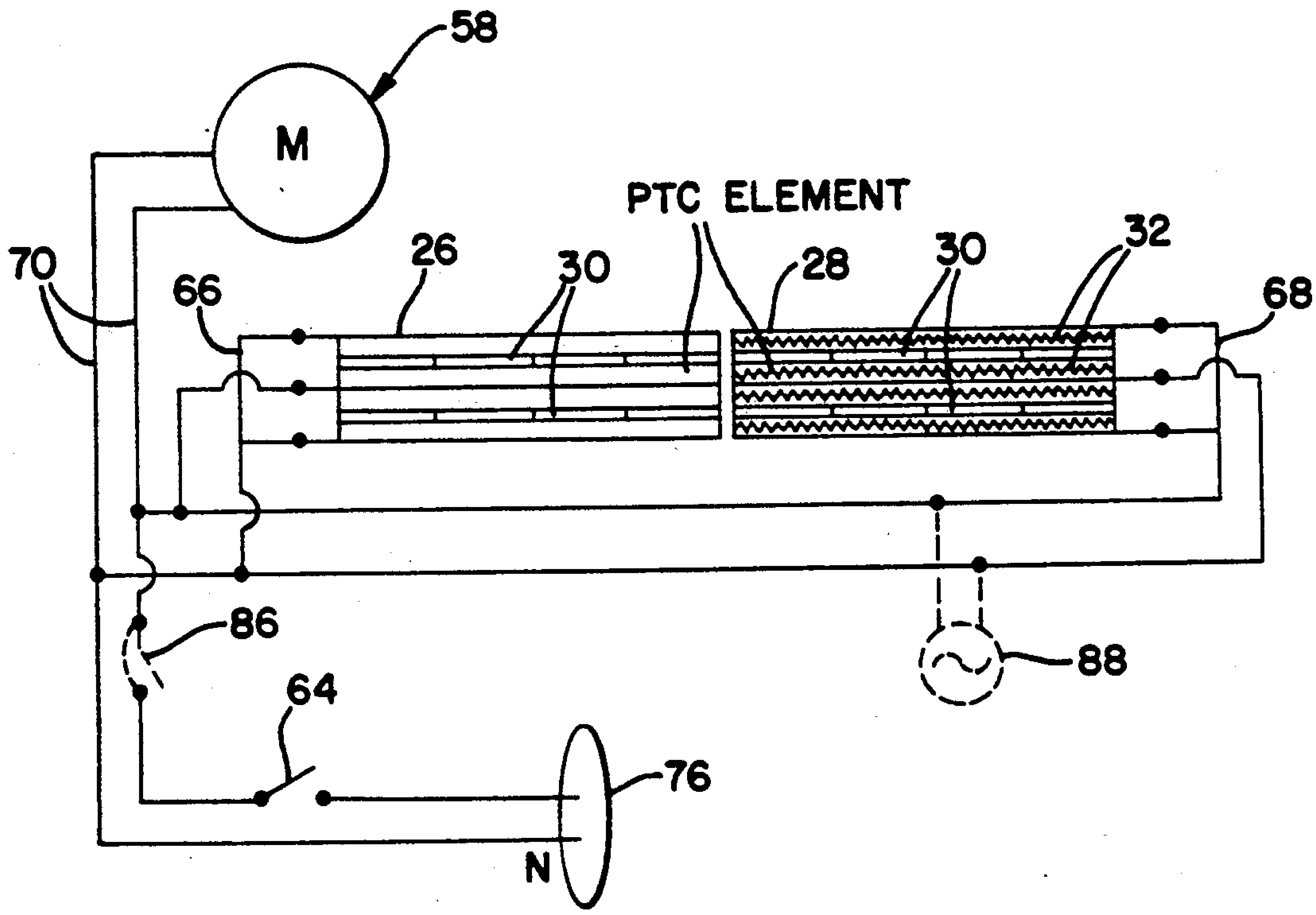
58
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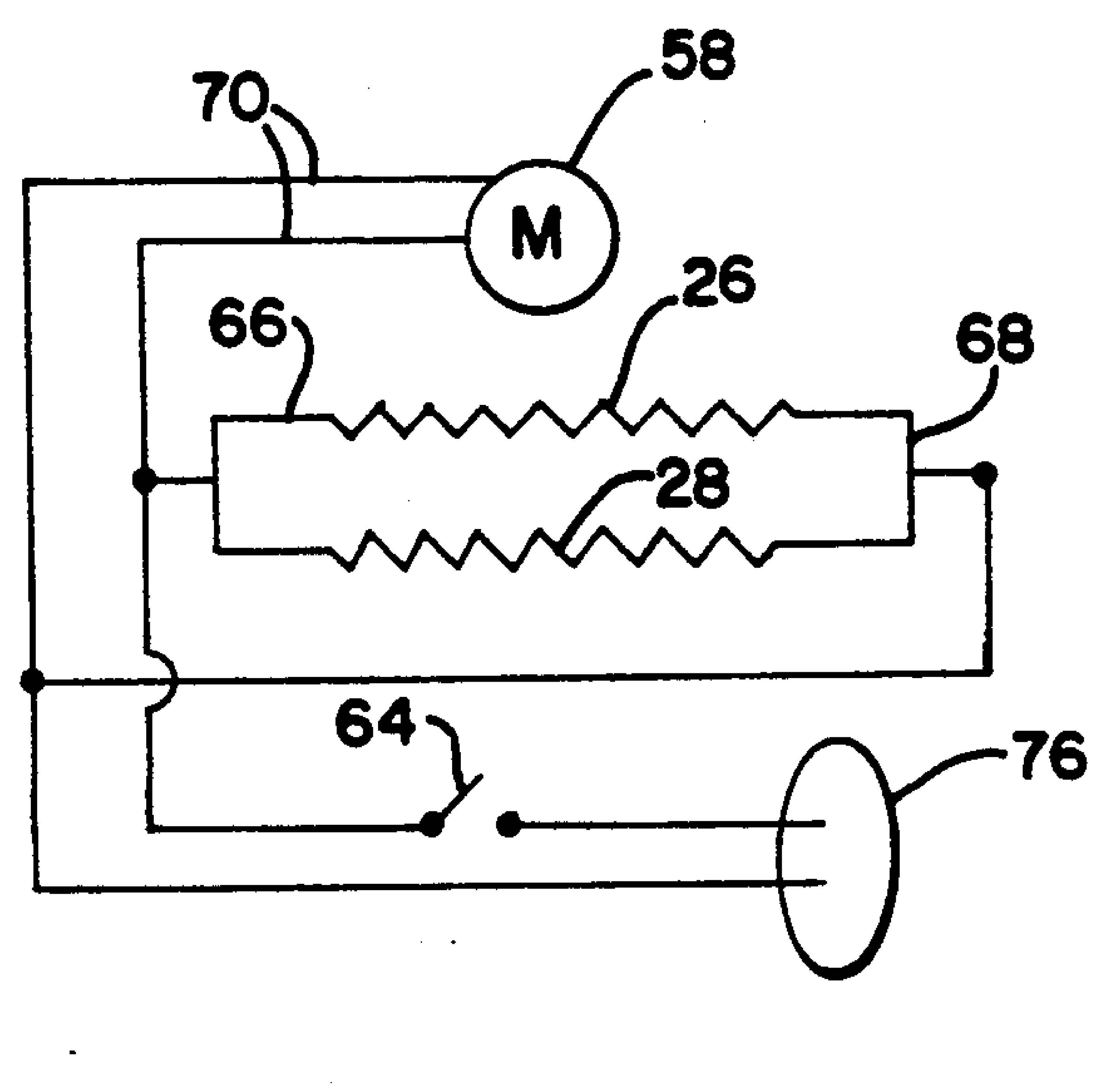
FIG. 8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FIXED VOLUME PTC AIR HEATER WITH HEAT OUTPUT ADJUSTED BY A DAMPER CONTROLLING AIR FLOW OVER THE PTC ELEMENT

BACKGROUND OF THE INVENTION

This invention relates to air heating devices, and in particular to an electric air heater having a fixed volume airflow with damper control to determine the heat output.

Conventional, electric air heaters share many of the same concepts, such as:

1. Almost all heaters employ Nichrome type heating elements in one form or another, which are heated to extreme temperatures. Some such heaters used forced air and others use natural draft or convection for heat transfer.

2. Almost all conventional heaters utilize electrical or electro-mechanical switching to deenergize the heating elements for control of heat discharged. Such controls normally take the form of thermostats or similar elements.

3. Whenever an abnormal condition arises, such as when a motor fails to deliver air or air discharge is physically blocked, almost all heating devices depend on some kind of thermo-limiting device to deactivate the heating elements to prevent a fire or electrical breakdown. This can be accomplished through the use of limit controls or some other form of thermally active limiting device. Often such controls or devices become very complex, even to the extent of employing secondary backup controls in the event that the primary control also fails to function.

4. Most conventional air heaters that are permanently installed are comprised of assemblies which must be fitted together to form the final device, from simple enclosures with cover plates, to segmented devices which are joined on site during installation. As a result, some devices are simple to install while others are complex, requiring skilled, knowledgeable installers for proper installation.

Conventional electrical air heating appliances use heat sources which can often reach temperatures as high as 1600° F., well above the combustible limit of most nonmetallic materials. The safe operation of such heaters is dependent on the operation of limit devices which turn off the heating elements during an abnormal situation. In contrast, in conventional PTC (positive temperature coefficient) heaters, the possibility of overheating and fire is not present. PTC elements are self-limiting as far as temperature of the elements. This self-limiting phenomena is the function of the physical chemistry of the doped ceramic material of which the PTC element is made.

The typical PTC element has an internal fixed value of resistance based on a given temperature. As the temperature rises or falls, so does the resistance of the PTC element. Typically, at around 340° F., the resistance of an element rises to a point to completely eliminate the flow of current through the element, thus stopping any further temperature rise of the element. This self-limiting feature will avoid an overheating condition (and consequential possible fire), and is the primary difference between a conventional heating source that employs wire heating elements and one which employs PTC elements.

SUMMARY OF THE INVENTION

The invention is directed to an electric air heating device which comprises a heat transfer body, and means for inletting air into the heat transfer body and means for outletting air from the heat transfer body. Locating within the body is heat transfer means comprising a pair of separate air paths, a PTC heating element located in one of the air paths, and means for controlling airflow through the air paths, the airflow controlling means including an adjustable regulator which, when adjusted, increases airflow in one of the two air paths and decreases airflow in the other of the air paths. For moving air through the heat transfer body, an appropriate means is provided for supplying air to the separate air paths.

In accordance with the preferred form of the invention, the heat transfer body is mounted in a housing which, as is conventional, is normally mounted in a wall, if the device is small enough, or is mounted in a stand-alone orientation with heat being ducted to remote locations. When the device is wall mounted, means is provided for spacing the heat transfer body from the housing, the means preferably comprising a series of spaced, insulative isolation pads located between the body and the housing.

The PTC heating means comprises a plurality of PTC elements, the number of elements depending on the design capacity of the heating device. The adjustable regulator, in the preferred form of the invention, comprises a horizontal damper, with an arm extending from the damper for adjustment. The damper extends over the air paths, which are located in a fore-and-aft relationship. The damper is mounted for lateral movement from a first position preventing airflow in one air path and permitting full airflow in the other air path to a second position preventing airflow in the second air path and permitting full airflow in the first air path. The arm is slideably mounted on the damper on a pair of guide posts extending from the damper through a slot in the arm such that transverse movement of the arm creates the lateral fore-and-aft movement of the damper.

When the damper is fully closed over the air path carrying the PTC heating elements, the elements are deenergized. To accomplish this result, it is preferred that an electrical switch for the elements be located adjacent the damper arm and be engaged by the damper arm when the damper is closed in order to deenergize the elements.

Preferably, for supplying air, the invention includes a scroll blower. The blower is driven at a constant rate for establishing a fixed volume of airflow through the body. By judicious adjustment of the damper, the heat exiting the heating device can be very closely controlled.

In a wall-mounted orientation, the invention includes an air grill for the air inlet and an air grill for the air outlet. The inlet grill includes air filter media to remove any contaminants from the air before entering the heat transfer body.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described in greater detail in the following description of an example embodying the best mode of the invention, taken in conjunction with the drawings, in which:

FIG. 1 is a front elevational illustration of an electric air heating device according to the invention,

FIG. 2 is a side elevational view thereof, with portions broken away to illustrate detail,

FIG. 3 is an elevational view similar to that of FIG. 1, but with portions of the front cover removed to illustrate detail, and also with certain elements omitted to simplify the drawing somewhat,

FIG. 4 is a view similar to FIG. 3, but with the front cover completely removed, and with all internal elements in place,

FIG. 5A is a schematic top plan illustration of the damper employed by the invention, showing substantially full opening of the damper for maximum heat output from the heating device,

FIG. 5B is a view similar to that of FIG. 5A, but with the damper substantially fully closed to minimize heat output from the air heating device of the invention,

FIG. 6 is a schematic side elevational illustration of the airflow paths within the air heating device of the invention,

FIG. 7 is a schematic illustration of the electrical circuitry for the air heating device of the invention, and

FIG. 8 is a simplified schematic view of the electrical circuitry of FIG. 7.

DESCRIPTION OF AN EXAMPLE EMBODYING THE BEST MODE OF THE INVENTION

The present invention utilizes PTC heating elements as a heat source. A PTC element is a solid state thermally sensitive resistor with fixed tolerances based on temperature. When a voltage potential is applied, the current, internal resistance and ultimate power of the PTC element are proportional to the ambient temperature to which the material of the PTC element is exposed. The PTC element is self-limiting, in that at a maximum fixed temperature of about 340° F., the element draws little or no power. Only as the core temperature of the element is reduced below this fixed point does the power again rise, thus increasing the heat output.

The present invention utilizes airflow to control temperature output. As the airflow over the PTC elements is increased, the core temperature of the elements falls, producing a drop in internal resistance which causes more current to flow, in turn raising the core temperature and consuming more electrical power. The temperature output is thus increased. Conversely, a reduction in temperature output is obtained by reducing the airflow over the PTC elements which consequently increases internal resistance, reducing current flow and therefore consuming less power. The invention is therefore inherently self-limiting, in that never can the PTC heating elements rise to a temperature that would be anywhere near the combustion limit of adjacent materials, such as wood structural members, or fabrics or paper. Even so, the invention employs two basic elements, an outer housing and the heater unit itself, with the heater unit being spaced from the outer housing.

An air heating device according to the invention is generally designated at **10** in the drawing figures. It comprises an outer housing **12** and a heater or heat transfer body **14** which is mounted in the housing **12**. An ornamental cover **16** is used to provide an aesthetically pleasing finish for the air heating device **10** when installed. For the purposes of description, the front of the air heating device **10** is designated at **18**, although such terminology is relative, depending on the configuration of the air heating device **10** and its installation.

The heat transfer body **14** is mounted in and spaced from the housing **12** with several isolation pads **20**, which may be silicone sponges or similar materials. Not only do the pads **20** provide heat insulation, but also noise isolation, as well. Single top and bottom screws (not illustrated) may be employed for securing the heat transfer body **14** within the housing **12**.

The heat transfer body **14** is internally divided into a pair of separate air paths **22** and **24**. The air path **22** is simply an open duct, while the air path **24** includes a pair of PTC heating devices **26** and **28** (FIG. 7), each of which is composed of a plurality of conventional PTC heating elements or chips **30**, separated by a finned area **32** or other appropriate means to allow through passage of air. Each of the PTC heating devices **26** and **28** is mounted on an appropriate support **34** within the heat transfer body **14**.

An adjustable damper **36** is used to regulate airflow through the air paths **22** and **24**. As explained above, the damper **36** also acts as a temperature regulating device, as will be described in greater detail below. The damper **36** is formed of a suitable material, such as high temperature plastic or metal, and is guided in a pair of slots **38** and **40** mounted in the heat transfer body **14** just above the PTC heating devices **26** and **28**.

An arm **42** is used for controlling the relative position of the damper **36**. The arm **42** includes a central slot **44** which is engaged upon a pair of upstanding guide posts **46** and **48** secured to the damper **36**. A guide **50** is mounted on the arm **42**, and includes a stop **52**. The guide **50** may be made of Teflon or a similar low friction material to avoid sliding interference with the cover **16**, as explained below. The arm **42** is capped with an operating knob **54** which is used for control of the arm **42**, and consequentially the damper **36**.

A blower assembly is used to provide airflow through the air heating device **10**. The blower assembly is composed of a scroll blower **56** driven by a motor **58**. The blower assembly is mounted in a housing **60** which is secured to the heat transfer body **14** by means of suitable mounting pegs and lock nuts **62**, or similar mounting devices.

A microswitch **64** is used for initial control of the air heating device **10**. In its right-most excursion, the stop **52** of the arm **42** engages the microswitch **64**, deenerqizing power to both the blower motor **58** and PTC heating devices **26** and **28**.

The PTC heating devices **26** and **28** each include wires **66** and **68** for energization, and the motor **58** similarly includes wires **70**. All wires pass through a bushing **72** of a wire compartment **74** and thence to a power source **76** remote from the air heating device **10**. The microswitch **64** is interposed in the supply line leading to the motor **58** and PTC heating devices **26** and **28**, in a conventional fashion.

The cover **16** includes an upper air inlet grille **78** and a lower air outlet grille **80**. The inlet grille **78** includes an air filter media **79** filtering air entering the air heating device **10**. The arm **42** of the damper **36** extends through a slot **82** in the face of the cover **16**. Appropriate indicia **84** may also be included on the cover **16** to readily indicate the direction to which the arm **42** must be shifted for increasing or decreasing the heat output of the air heating device **10**.

Although unnecessary to proper operation of the air heating device **10**, an alternate internal thermostat may be employed for controlling the PTC heating devices **26** and **28**, and the blower motor **58**. A thermostatic switch (not illustrated), may be appropriate located in the cover **16**, accessible to the user. In addition, again although not necessary for proper operation of the air heating device **10**, an alternate limit control **86** can be employed to deenergize the PTC heating devices **26** and **28** and blower motor **58** if any situation of abnormal operation occurred. Finally, a pilot light **88** may be provided through an opening in the cover **16** (not illustrated) to indicate when the PTC heating devices **26** and **28** are operating.

Operation of the air heating device **10** is governed by the position of the damper **36** which is controlled by the arm **42**. With the arm **42** in its right-most position (FIGS. **4** and **5B**), the stop **52** engages the microswitch **64**, opening the electrical circuit to the PTC heating devices **26** and **28** and blower motor **58**, preventing operation of the air heating device **10**. The arm **42** protrudes through the slot **82**, sandwiching the cover **16** between the guide **50** and the knob **54**.

As the arm **42** is slid transversely to the left, the microswitch **64** is closed, energizing the PTC heating devices **26** and **28**, and motor **58**. Air therefore is drawn through the inlet air grille **78** by the scroll blower **56**, and passes through the air paths **22** and **24**, the proportion of air passing through the respective air paths depending on the position of the damper **36**. Heated air then exits the air heating device **10** through the outlet air grille **80**.

The position of the damper **36** governs the quantity of air heated. In the position shown in FIGS. **2** and **6**, the damper **36** is midway across each of the air paths **22** and **24**, thus allowing approximately half of the airflow through each air path. In the position shown in FIGS. **1** and **5A**, the damper **36** is drawn to its forwardmost excursion, essentially completely covering the air path **22**, and thus allowing airflow only through the air path **24**. This is the position of maximum heat output, since all air is passing through the air path **24**, past the energized PTC heating devices **26** and **28**. Conversely, however, when the damper **36** is in the position shown in FIG. **5B**, the damper **36** essentially covers most if not all of the air path **24**, thus allowing most air to bypass the PTC heating devices **26** and **28**. In that orientation, very little, if any, heating of air occurs before it exits through the outlet air grille **80**. As explained above, because of the self-limiting nature of the PTC elements **30**, overheating does not occur no matter what the position of the damper **36** in relation to the air paths **22** and **24**.

While the air heating device **10** is shown in the form of a wall-type installation, it should be evident that, depending on the heat output of the device **10** and locations to be heated, the device **10** can be provided in a stand-alone orientation with ducting of heated air to locations to be heated. The form shown in the drawing figures is preferred.

ACHIEVEMENTS

By providing a pair of air paths, only one of which has heating elements therein, and a damper for controlling relative airflow through the two air paths, the present invention provides a unique manner of regulating airflow and heat output. Conventional heating devices require thermostating switches to turn heating elements on and off to prevent overheating, but in the present application, when the damper has been placed in one position, the heat output will remain constant so long as the damper remains in that position. No matter where the damper is located, air output from the heating device is constant since the blower motor is driven at a constant rate. This allows for designing the device to provide minimum air friction and noise.

Because the air paths are located centrally within the air heating device, and because the outlet grille is disposed at 90° relative to the air paths, heated air and bypassed air are blended within the device before being discharged through the outlet grille, providing for uniform heating.

Various changes can be made to the invention without departing from the spirit thereof or scope of the following claims.

What is claimed is:

1. An electric air heating device comprising

a. a heat transfer body,

b. means for inletting air into said body and means for outletting air from said body,

c. heat transfer means located in said body, said heat transfer means comprising

i. means defining a pair of separate and distinct air paths in said heat transfer body,

ii. a fixed PTC heating means located in one of said air paths across said one air path, and

iii. means proximate said PTC heating means and spaced a fixed distance therefrom for controlling airflow through said air paths, said airflow controlling means including an adjustable, shiftable regulator which when adjusted increases airflow in one of said air paths and decreases airflow in the other of said air paths, and

d. means in said heat transfer body for supplying a constant fixed volume of air to said separate air paths.

2. An electric air heating device according to claim **1** in which said means for inletting air comprises an air grille.

3. An electric air heating device according to claim **2** in which said air grille includes an air filter media.

4. An electric air heating device according to claim **1** in which said means for outletting air comprises an air grille.

5. An electric air heating device according to claim **1** including a housing, said heat transfer body being mounted in said housing.

6. An electric air heating device according to claim **5** including means spacing said body from said housing.

7. An electric air heating device according to claim **6** in which said means spacing comprises a series of spaced, insulative isolation pads located between said body and said housing.

8. An electric air heating device according to claim **1** in which said PTC heating means comprises a plurality of PTC elements.

9. An electric air heating device according to claim **1** in which said adjustable regulator comprises a damper, and in which said airflow controlling means includes an arm extending from said damper for adjustment of said damper.

10. An electric air heating device according to claim **9** in which said air paths are located in a fore and aft relationship, and in which said damper is mounted for lateral movement from a first position preventing airflow in one air path and permitting full airflow in the other air path to a second position preventing airflow in the other air path and permitting full airflow in the one air path.

11. An electric air heating device according to claim **9** in which said damper is mounted for lateral movement in said heat transfer body across said air paths and in which said arm includes a longitudinal slot, said arm being slideably mounted on said damper on a pair of guide posts extending from said damper through said slot such that transverse movement of said arm creates lateral movement of said damper perpendicular to the direction of travel of said slot.

12. An electric air heating device according to claim 1 including means for energizing said PTC heating means and said means for supplying air.

13. An electric air heating device according to claim 12 in which said means for energizing comprises a switch.

14. An electric air heating device according to claim 13 including an arm extending from said regulator, said arm being mounted to activate said switch.

15. An electric air heating device according to claim 1 in which said means for supplying air comprises a scroll blower.

16. An electric air heating device according to claim 15 including means for driving said blower at a constant rate for establishing a fixed volume of airflow through said body.

* * * * *